Mechanical characterization of regenerating Hydra tissue spheres

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Abstract

Hydra Vulgaris is a fresh water polyp known for its regenerative capabilities. Each piece excised from its body can reform, in a few days, a new complete and functional *Hydra*. The observed influence of tissue mechanics on their regeneration suggests that there is a mechano-biological coupling at play. However, the study of such coupling has suffered from a lack of knowledge of the mechanical properties of regenerating *Hydra* samples. Here, we used a novel parallel micro-aspiration setup and numerical simulations to fill this gap. We demonstrated that the rheology of *Hydra* tissue spheres displays three different regimes depending on the applied stress: elastic, visco-elastic and finally tissue rupture. Using models of deformable spherical shells, we were able to determine the Young modulus and viscosity associated with the elastic and viscous phases as well as the stresses required to switch between these different responses, including the critical stress inducing tissue rupture. This full mechanical characterization therefore offers a first step for the future elaboration of new models of *Hydra* patterning based on experimental results and including both the mechanical and biochemical levels.

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